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ABSTRACT

Monitored Finance, Usury and Credit Rationing

by Michael Tröge

The paper analyzes the repeated interaction between a bank and a firm. A simple two period model is constructed, which explains several features of a credit relationship: It shows why bank finance is available for firms which cannot obtain bond financing, why credit contracts contain a “Material Adverse Clause” and why interest rates quoted by banks do not depend very much on risk. The model shows why, even if the interest rate is observed, other banks cannot take over the credit. This model is then used to give a new explanation for credit rationing. It is argued that banks may have to maintain a reputation for treating firms correctly. They will be reluctant to finance risky firms, because these credits will have to be renegotiated with a high probability which will endanger the bank's reputation. Rationing of this type can arise either in stable economies with a lot of low risk firms or in a highly risky environment. Non profit-maximizing public banks may then be necessary in order to subsidize small or risky firms.

ZUSAMMENFASSUNG

Kreditüberwachung, Wucher und Kreditrationierung

In dem Aufsatz wird die wiederholte Interaktion zwischen einer Bank und einer Firma untersucht. Es wird ein einfaches Modell einer Kreditbeziehung berechnet, das mehrere Eigenschaften einer Kreditbeziehung erklären kann. Es wir gezeigt, warum Firmen durch Banken finanziert werden können, die auf dem Kapitalmarkt keine Bonds ausgeben könnten. Es erklärt, warum Kreditverträge eine „Material Adverse Clause“ enthalten , warum Zinssätze so wenig risikoadjustiert sind und warum Banken den Kredit eines Wettbewerbers nicht übernehmen können, auch wenn sie den Zinssatz beobachten. Dieses Modell wird im zweiten Abschnitt der Arbeit dazu verwendet, Kreditrationierung zu erklären. Es wird gezeigt, daß Banken Anreize haben können, Reputation für korrektes Verhalten aufrechtzuerhalten. Diese Reputation könnte gefährdet werden, wenn Banken zu viele risikoreiche Firmen finanzieren. Sie müssen dann häufig Kreditverträge nachverhandeln, was von Neukunden als Versuch ausgelegt werden könnte, Informationsrenten aus der Kreditbeziehung abzuschöpfen. Deshalb werden Banken versuchen, den Anteil an risikoreichen Firmen gering zu halten. Es wird gezeigt, daß Rationierung dieses Typs vor allem in sehr risikoreichen oder sehr stabilen Volkswirtschaften auftritt. In diesem Fall kann es sinnvoll sein, risikoreiche, innovative Firmen durch nicht profitmaximierende öffentliche Banken zu finanzieren.

1 Introduction

The attitude of banks with respect to credit risk has puzzled economists for a long time. The interest rates banks quote do not differ very much among firms of different riskiness. For example Machauer and Weber (1998) analyze the dependence of interest rates on a bank's own internal rating of borrowers. In their sample, the average interest rate difference between borrowers in the best and the worst of five risk classes is only 1.2%. Given that the best class is defined as "good or very good creditors" whereas the worst class consists of borrowers which are "very much in danger of default" these interest differences are much smaller than the interest rate spreads on corporate bonds of comparable ratings. In addition, the results of Petersen and Rajan (1994) or Blackwell and Winter (1997) seem to indicate that the variations of the interest rate can rather be explained with differences in bargaining power or credit market competition than with the riskiness of a loan.

Instead of increasing the interest rate in order to compensate for the risk, banks seem to turn down credit for perfectly profitable but risky firms, or restrict the amount of credit to a firm with a profitable project. This behavior is referred to as credit rationing. Note that not every borrower is being rationed if he doesn't receive financing, even if he is willing to accept a higher interest rate. The bank's refusal to lend may be justified, because the borrower's project has negative value. Following Keeton (1979) two sorts of rationing can be distinguished: the rationing of the number of loans but not of the loan size is called type I rationing, whereas an inefficient reduction of the loan size is referred to as type II rationing. It is evident that rationing can have considerable consequences for the development of an economic system, especially in countries where banks are the dominating source of finance. Innovative projects with high returns but also high risk will not be financed, the efficiency of the allocation of capital will decrease.

Credit rationing behavior was already postulated in the 1950s by Roosa (1951) and Scott (1957) who argued that monetary policy operates through the availability of loans

rather than the interest rate. However, it was only at the end of the 1970s that attempts were made to explain credit rationing as an equilibrium phenomenon. Jaffee and Russel (1976), Baltensperger (1978) and Keeton (1979) have clarified the concept and pioneered the asymmetric information approach which culminated in the influential paper by Stiglitz and Weiss (1981). The key effect in the Stiglitz/Weiss model is that interest can only be paid in case a project succeeds. As firms do not pay for the downside risk, the expected interest rate for a risky project is lower than the one for a safe project. Hence, if the bank increases the interest rate, entrepreneurs with safe projects will not apply for finance any more whereas entrepreneurs with risky projects of the same expected payoff will still be willing to take the credit. Alternatively, safe entrepreneurs may try to increase the riskiness of their projects. Because of these adverse selection and moral hazard effects, higher interest rates may eventually lead to a lower profit for the bank. The bank will be forced to quote a low interest rate for which the demand for capital is higher than the supply. Therefore, some borrowers will be rationed.

A different line of research, including Townsend (1979), Gale/Hellwig (1985) and Williamson (1986) and (1987) obtains credit rationing as a side effect of theories initially developed for explaining the optimality of debt contracts under asymmetric information. Rationing is here the consequence of ex post monitoring or bankruptcy costs. In the Williamson (1986) model, banks are reluctant to ask high, risk-adjusted interest rates because this increases the probability of failure and therefore the bankruptcy costs.

The Stiglitz/Weiss approach has been criticized from several sides. Riley (1987) has observed that rationing of this type should not be frequent if banks can distinguish the riskiness of firms. DeMeza and Webb (1987) show that the results of Stiglitz/Weiss rely on a special assumption on the distribution of risk in the population of firms. Given the theoretical weaknesses, it is not surprising that empirical studies have not succeeded in observing the effects implied by the asymmetric information approach to credit rationing. Berger and Udell (1992) show that loan rate stickiness does not change in a way consistent with asymmetric

information theories of credit rationing. Cressy and Toivanen (1997) develop a test in order to directly decide between theories using symmetric versus asymmetric information. Their results suggest that information is imperfect, but symmetric.

In this paper, it is argued that the asymmetric information approach, while valuable for commercial bonds and other types of arm's length debt, is misleading when used to analyze relationship banking which is typical for continental Europe and especially Germany. As argued by Albach (1997), on the contrary, the good information of the bank about the firm and the mutual trust is the key to understand the advantages of bank financing and the problems that may arise.

Monitored finance The idea that finance provided by a well informed bank may increase the efficiency of firms has been used by several authors in recent papers. Carminal and Matutes (1997) assume that after having invested in monitoring, banks can directly influence the decisions of the firms and will do this in a socially beneficial way. In Holmström and Tirole (1997) monitoring by a bank alleviates moral hazard by decreasing the private benefits of risky behavior. In this paper, a different mechanism is proposed which explains why banks can provide more efficient corporate governance than bond markets .

It is argued that the decisive difference between a bank loan and a bond is that, whereas the interest rate and the duration of a bond are fixed once for all (except the violation of prespecified covenants), most credit contracts contain an unspecific "Material Adverse Clause" (MAC) which gives the bank the discretion to call back the credit or increase the interest rate whenever this seems appropriate. In fact, this seems to be more common for relationship based banking than for economies where arm's length finance prevails. It is anecdotal evidence that credit contracts in Germany are far less detailed and give the bank much more discretion than in the United States. Typically in the United States the "Material Adverse Clause" only applies to loan commitments, whereas in Germany it is included in almost all credit contracts.

The economic function of the MAC cannot be analyzed if the firm is modeled as a one shot random variable like in most of the asymmetric information literature. The MAC makes only sense if distress situations do not occur suddenly but can be anticipated by a bank. This idea is formalized in the model presented in section 2. The models closest to this setting are Rajan (1992) and Rajan (1995). Rajan focuses on the incentives to obtain efficient liquidation and gives the bank the right to change the financing conditions only at the end of a loan contract or if prespecified covenants are violated. In contrast to this, here it is assumed that the bank is free to choose the timing and the type of its action, which is definitely more typical for European-style relationship banking. It then does not make much sense to assume that the bank will lose money when liquidating. In general, a closely monitoring bank will step in before this state of distress is reached.

The discretion to raise the interest rate gives the bank the possibility to provide efficient incentives to the entrepreneur. The intuition of this result is very simple: the entrepreneur is interested in increasing the riskiness of his project as long as the interest rate he has to pay is fixed. However, if the increased risk is observed by the bank and it adapts the interest rate, the entrepreneurs incentives to increase risk disappear.

Whereas the good and possibly exclusive information of the bank increases the efficiency, it may have negative effects on the competitiveness of the market. There are two reasons why banks that have not monitored the firm will incur a higher credit risk. They are not able to anticipate risky situations and react appropriately and this in turn leads to inefficient incentives for the firms which further increases credit risk. Hence banks that have not monitored the firm will not be able to provide credit even if they can observe the interest rate offered by the monitoring bank. Monitoring on the other hand is not profitable for an outsider as he will never recoup his monitoring costs. Hence the flexibility of the credit contract, together with informational advantage of the bank, explains the possibility of ex post rent extraction.

Reputation Of course, giving the bank the possibility to change the credit contract in a situation where outside banks cannot step in, creates a problem of moral hazard at the side of the bank. Banks may simply claim that the firm's rating has deteriorated. Asking a higher interest rate is only one of the possibilities to extract additional rents. Another practice which becomes increasingly popular in Germany with banks diversifying into consulting is to send the banks consulting or restructuring team to the firm and charge a hefty bill for these "services".

The most efficient solution for the moral hazard problem of the bank would be to directly condition the contract on the credit risk. However, credit risk is probably a variable that is not verifiable in court. It can only be tried to capture credit risk as closely as possible with verifiable covenants. However, as there are always unforeseen contingencies, covenants are never perfectly correlated with the credit risk. Efficiency can only be approached by more and more complex contracts.

This paper argues that relationship finance prevailing in continental Europe uses another mechanism. Typically changes in the terms of the credit contract are left very much at the discretion of the lender. It seems that the banks' reputational concerns prevent them from misusing their power. In fact, discretionary contracts and reputation are complementary features. Boot at alii (1993) have shown that banks relying on a reputational mechanism may even leave contractual features discretionary that could in principle be enforced by courts. Using discretionary contracts instead of legally enforceable ones, facilitates the development of reputation.

The importance of reputation in bank-firm relationships has been recognized by several authors. Whereas Diamond (1989) and (1991) analyzes the impact of the debtor's reputation on his cost of finance and project choice, Sharpe (1990), Cemmanur and Fulghieri (1994) and Dinc (1997) have pointed out the importance of the bank's reputation. Closest to the model used in this paper is Sharpe (1990) who also assumes that the banks acquire a reputation not to exploit informational rents. Cemmanur and Fulghieri (1994) focus on the decision of

the financier to liquidate a firm in financial distress or renegotiate the credit. They show that reputational concerns will incite banks to make more costly evaluations of the firm than bondholders in order to take the correct decision. Dinc (1997) considers the incentives of banks to observe discretionary loan commitments.

Similarly to these papers, it is shown in section 3 how in a repeated game banks will treat customers correctly in order not to lose profits from future financing relationships. However, the main focus is not the reputation mechanism itself but its possible disadvantages. It is demonstrated how the necessity to maintain a good reputation may lead to type I credit rationing.

The intuition is very simple: some of the actions which are appropriate for a firm in difficulties can as well serve to exploit perfectly healthy firms. If firms are not able to distinguish between a bank exploiting healthy firms and a bank recovering its credits in a bankrupt firm, they may misinterpret a justified action as usurious practices. In order to avoid being suspected to be a usurer, banks may prefer not to finance too many risky firms.

In a recent paper Carey et alii (1996) provide strong empirical support for this explanation. They compare the differences in the credit portfolios of finance companies and banks and observe that finance companies lend to significantly riskier borrowers. Carey et alii (1996) suggest that this is because finance companies care less about their reputation. However, they do not explicitly model this, nor recognize the possible implications of reputation on credit rationing. Their paper shows that some risky firms which have been refused by reputation-based banks have the possibility to get arm's length finance from a finance company. However, a lot of firms which could in principle be financed with monitored bank debt may not be able to get arm's length finance because then the Stiglitz/Weiss moral hazard problem becomes relevant. In this sense, the basic mechanism of credit rationing used in this paper is the same as in Stiglitz/Weiss. However, the paper does not apply it to banks but only to arm's length finance. The proposed explanation of credit rationing neither needs the assumption of asymmetric information between a bank and a firm, nor risk aversion of

the bank. Note that whereas the bank is not risk averse in the economic sense of having a concave utility function, it behaves risk adverse in a common language sense, as it refuses to finance risky but profitable firms.

A key insight of the model is that it may not be sufficient to look at a single bank-firm relationship if one wants to explain why a firm is rationed credit. In section 3, it will be shown that rationing depends on the risk profile of the entire economy. Identical banks may be willing to finance the identical firm in one particular economic environment but not in another.

Note that the danger of usurious practices explains the astonishing popularity and the success of non profit-maximizing financial institutions especially in developing, but also in industrialized countries. Allan and Gale (1995) point out that a substantial fraction of total banking assets in Germany are held by savings banks. They are not profit maximizing entities, but were originally set up to provide credit to the poor and finance local and regional investments and continue at least partially to pursue these objectives. Only 26% of total banking assets in Germany are held by private commercial banks whose attachment to shareholder value maximization is at least doubtful, given their managerial entrenchment documented by the Monopolkommission (1998).

The model also shows that it is in principle not unreasonable to subsidize risky but promising firms with credits from a public bank such as the Kreditanstalt für Wiederaufbau (KfW), the European Investment Bank (EIB) or the European Bank for Reconstruction and Development (EBRD). A non profit maximizing public bank doesn't need to sustain a reputation. It can provide first best incentives, because the firm has no reason to fear that it will be exploited. Of course it might be difficult to regulate the public bank appropriately. Without having to maximize profits it may have the tendency to be too lenient.

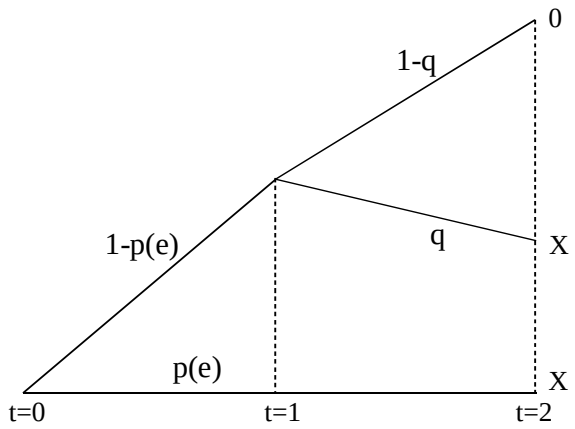

Figure 1: Time structure of a lending relationship

2 Monitored finance

2.1 The model

A lending relationship extends over three points in time. At $t = 0$, firms need an investment which is normalized to 1, in order to generate a success cash flow of X at $t = 2$. However, at $t = 1$, with probability $1 - p(e)$, depending on the invested effort of the entrepreneur $e \in [0, \infty]$, the firm enters in a risky situation.

This is described by assuming that the probability of success decreases considerably to q. The function $p : [0, \infty] \to (0, 1)$ is assumed to be increasing and concave i.e. $p'(e) > 0$, $p''(e) < 0$. Having invested the monitoring costs c, a bank is able to observe this change in the credit quality of the firm. If the credit contract contains a "materially adverse" clause, it can react by either liquidating the firm and recovering $L < qX$, or increasing the interest rate. Figure **??** summarizes the structure of the model.

First best solution: The overall surplus created by the project is

$$[q(1 - p(e)) + p(e)]X - 1 - e, \tag{1}$$

hence the first best effort e^* is characterized by:

$$\frac{\partial}{\partial e} p\left(e_{FB}\right) = \frac{1}{\left(1-q\right) X} \tag{2}$$

In the sequel, p^* will be used as shorthand notation for $p\left(e^*\right)$. The first best surplus plus the effort costs will be denoted by $\Pi_{FB} := \left[q - q p_{FB} + p_{FB}\right] X - 1$.

Limited liability and contingent contracting: Assume that the deterioration of the borrowers credit rating is a contractible contingency or that the bank is a welfare maximizing institution. Then the first best solution can be implemented by conditioning the contract on the credit risk. Denoting the repayment in the riskless case by b_s and by b_r, the repayment in the risky situation, the borrower will chose his effort such that:

$$\max_{e \in [0,\infty]} \left[\left(1 - p\left(e\right)\right) q \left(X - b_r\right) + p\left(e\right)\left(X - b_s\right) - e\right] \tag{3}$$

$$\Rightarrow \frac{\partial}{\partial e} p\left(e\right) = \frac{1}{\left(X - b_s\right) - q\left(X - b_r\right)} = \frac{1}{X\left(1-q\right) + q b_r - b_s} \tag{4}$$

Of course the bank has to make non-negative profits. Its participation constraint is:

$$p\left(e\right) b_s + \left(1 - p\left(e\right)\right) q b_r \geq 1 \tag{5}$$

Obviously, the firm owner has higher incentives to invest effort, if the interest rate increases in the risky state. He will choose the first best effort if:

$$\frac{1}{X\left(1-q\right) + q b_r - b_s} = \frac{1}{\left(1-q\right) X} \tag{6}$$

$$\Rightarrow q b_r = b_s, \tag{7}$$

i.e. if the increase in the interest rate exactly offsets the risk.

Arm's length contracts: If the bank is not monitoring or the credit contract does not contain a "materially adverse" clause, the repayments must be equal in both states, i.e. $b_s = b_r = b$. In this case the firm will invest effort such that

$$\Rightarrow \frac{\partial}{\partial e} p\left(e_{AL}\right) = \frac{1}{\left(X-b\right)\left(1-q\right)} > \frac{1}{\left(1-q\right)X} \tag{8}$$

If the bank makes zero profit, this implies an interest rate of,

$$b = \frac{1}{\left[p_{AL} + \left(1-p_{AL}\right)q\right]} > 1 \tag{9}$$

Riskier projects require a higher interest rate, which in turn decreases the entrepreneur's incentives to invest effort. Therefore, arm's length finance may not be feasible from a certain riskiness on. The surplus created with arm's length contracts plus the effort costs will be denoted as $\Pi_{AL} := \left[q - qp_{AL} + p_{AL}\right]X - 1$.

Usurious practices: A firm that does not trust a bank has lower incentives to invest effort in its project. Assume that the firm assigns a probability of ρ to the possibility of being exploited by the bank. In this case, the bank increases the interest rate and deprives the firm of its entire surplus.

The effort chosen by the firm depends on the expectation of being exploited:

$$\max_{e\in[\mathbf{0},\infty]} \left[\left(1-p\left(e\right)\right)q\left(X-b_r\right) + p\left(e\right)\left(X-b_s\right)\right]\left(1-\rho\right) - e \tag{10}$$

$$\Rightarrow \frac{\partial}{\partial e} p\left(e\right) = \frac{1}{\rho\left(1-\rho\right)\left[\left(X-b_s\right) - q\left(X-b_r\right)\right]} = \frac{1}{\rho\left(1-\rho\right)\left[X\left(1-q\right) + qb_r - b_s\right]} \tag{11}$$

If X is big enough or q small enough, first best investment can still be achieved by raising b_r resp. lowering b_s until

$$\left(1-\rho\right)\left[X\left(1-q\right) + qb_r - b_s\right] = \left(1-q\right)X \tag{12}$$

$$\Leftrightarrow \frac{\rho}{1-\rho} X (1-q) = q b_r - b_s \tag{13}$$

However, not for all ρ, the bank's participation constraint may hold. If first best investment is implemented then the bank's profit π can be calculated as:

$$p_i^* b_s + (1 - p_i^*) q b_r - 1 = \pi. \tag{14}$$

Equations 13 and 14 can be solved for $b_r$and b_s.

$$\begin{aligned} b_s &= \pi + 1 - \frac{\rho}{1-\rho} X (1-q) (1-p_i^*) \\ b_r &= \frac{1}{q} \left(\pi + 1 + \frac{\rho}{1-\rho} X (1-q) p_i^* \right) \end{aligned} \tag{15}$$

With decreasing ρ the bank's profit has to decreases, otherwise the firms will turn to arm's length financing:

$$(1-\rho) (\Pi_{FB} - \pi) - e^* = \Pi_{AL} - e_{AL} \tag{16}$$

$$\Rightarrow \pi = \Pi_{FB} - \frac{\Pi_{AL} + e_{FB} - e_{AL}}{1-\rho} \tag{17}$$

The critical exploitation probability is:

$$\hat{\rho} = 1 - \frac{\Pi_{AL} + e_{FB} - e_{AL}}{\Pi_{FB}}. \tag{18}$$

For $\rho > \hat{\rho}$, trustworthy banks will not be able to offer a profitable credit contract.

Liquidation: It is assumed that liquidation is inefficient and that a bank liquidating the firm has not increased the interest rate beforehand. The liquidation value of the firm is L. If a bank is always liquidating in the risky state, the entrepreneur's maximization problem has the following form:

$$\max_{e \in [0,\infty]} \left[(1 - p(e)) \max \left[(L-b), 0 \right] + p(e) (X - b) - e \right] \tag{19}$$

under the participation constraint:

$$p(e)\, b + (1 - p(e)) \min[L, b] \geq 1 \tag{20}$$

$$\Rightarrow \frac{\partial}{\partial e} p(e) = \frac{1}{(X - b) - \max[(L - b), 0]} \tag{21}$$

Liquidation will induce first best effort if:

$$\frac{1}{(1 - q) X} = \frac{1}{(X - b) - \max[(L - b), 0]} \tag{22}$$

$$\Rightarrow qX = \max[L, b] \tag{23}$$

Inefficiency implies $qX > L$, as long as $b < qX$ liquidation will induce excess effort. Note that for low L the project may not have a positive value, so it may not be worthwhile to finance a project if they have to be liquidated in risky situations.

Competition The existence of monitoring costs explains in a straightforward way why competition to take over a credit at $t = 1$, will be weak. Without monitoring, outside banks cannot make a profitable offer. If they offer an interest rate between $b_s - 1$ and $b_r - 1$, they will only get the risky credits and make losses. If they offer an interest rate $1 + r > b_r$ they will get no credits, or in the limit case not make profits. Of course, monitoring is not worthwhile either, as they will never be able to recoup the monitoring costs, which the other bank has already sunk.

If initially several trustworthy banks are competing for the credit, the interest rate a firm has to pay in the safe state would be equal to the refinancing cost of the bank. This means that, in this case, credit market competition boils down to a pure private value auction. Of course, this is because we have excluded any common value factors, such as the possibility of immediate distress. However, the model shows that private value components may play a more important role than has been realized in most auction models of banking competition.

Note, however, that the efficiency-increasing role of flexible financial contracting is robust with respect to and may even be increased with intermediary competition. If we assume that $c = 0$, the intermediary interest rates the firm would be able to obtain in a competitive credit market without informational asymmetry would be the one that incites the first best effort. Indeed, as two monitoring and not colluding banks are sufficient for perfect competition, this may explain why most firms choose to maintain two bank relationships. Von Thadden (1994) has worked out this idea in a slightly different model, assuming that banks will deliberately encourage competition and introduce "second sourcing" in order to credibly commit to low interest rates. In a less competitive environment it seems more probable that the firms are the ones which do everything to prevent a hold up by a bank. They may establish "second sourcing" for credits by allocating credits to a second bank despite less favorable conditions. Empirically it has been shown by Harhoff (1998) that the majority of German firms receives credit from two banks. In the sequel, we do not pursue these ideas further, but simply assume a monopolistic bank.

2.2 Discussion

Despite its simple structure, several features of bank finance can be explained with this model. It shows how the flexible clauses of a credit contract together with a well informed bank, which is acting in the interest of the borrower, can increase the efficiency of finance. As a side result, it explains why initially interest rates are not risk adjusted but rather reflect the refinancing conditions of the bank. This also explains why banks have insufficient incentives to screen the borrower's quality very much before making a credit offer. Indeed, all they have to know about the borrower is that his project has a positive expected value. The precise risk of the firm is not very relevant. Anyway the initial interest rate does not depend on the firm's risk, as long as the credit risk is not too high.

Whereas there is no need for a bank to sink monitoring costs before the firm has accepted the credit offer, monitoring is necessary once the credit contract is signed. In contrast to

the Sharpe (1990) and Rajan (1992) models, it is not simply assumed that the banks acquire information during the lending relationship, but the information acquisition is modeled explicitly. It is shown that the banks will rather collect information that enables them to anticipate and deal with distress situations than information about the quality of the borrower. Therefore, the credits of one bank cannot been simply be transferred to another bank at the same interest rate. This is an explanation for Fishers (1933) observation, that the bankruptcy of banks may have severe consequences on the availability of credits for firms. Furthermore it provides a straightforward and robust explanation for the possibility of ex post rents.

Of course the model is very stylized. It could be made more realistic by reintroducing the possibility of a nonanticipated failure of the firm. This would add a common value component to the bank's evaluation of the credit. The banks would have to compensate this kind of risk with a risk premium form the beginning of the relationship on. However, as this premium would only include the imminent credit risk it will probably be quite small.

A richer version of this model could be constructed with techniques derived from option pricing. In reality new information influencing the credit risk of a bank arrives continuously in time, so that the credit risk follows a jump diffusion process. The bank can hedge against the continuous components of this process but is forced to compensate the jumps by risk premium. Like in Holmström/Milgrom (1987) the contract giving the entrepreneur optimal incentive to influence this process could be analyzed. It could be shown that highly volatile businesses make frequent monitoring necessary. The high monitoring costs could be a reason not to finance these projects or to prefer non-monitored incentives through equity finance.

3 Credit Rationing and Reputation

This part will analyze what happens if the bank is not a non-profit maximizing organization and if the credit risk is not contractible. It will be demonstrated how the phenomenon of

credit rationing can be explained by the necessity of the banks to maintain a good reputation. In fact, there are two distinct mechanisms which will lead to credit rationing under different circumstances. One will rather be observed in stable economies, the other will be prevailing in risky environments.

The intuition of the direct mechanism is easy to understand. If the contract allows the bank to increase the interest rate, firms are afraid to be exploited by the bank. They may observe the past behavior of the bank before applying for a credit. If they are not able to distinguish between justified and non-justified renegotiations of the interest rate, they may prefer not to go to a bank which has renegotiated too many credits. Anticipating this, honest banks may be reluctant to finance profitable but highly risky firms, for which the credits have to be renegotiated quite often. Banks have to trade off the losses from not financing risky firms today against the losses from its diminished reputation in the future. This mechanism becomes especially relevant if there are many firms with low risk and only a few risky firms. Banks will be reluctant to endanger their reputation in such a situation. They will not gain very much from financing the few high-risk firms, but may loose a lot if the low-risk firms do not come back in the future. This could be the reason why credit rationing is a concern in mature and stable economies like Germany. There the number of firms which can be financed almost without incurring risk is substantially larger than the amount of profitable but highly risky firms.

However, there is a second mechanism which indirectly leads to credit rationing in unstable environments. If the sample of firms is rather risky, credits have to be renegotiated very often. This means that, even at honest banks, a lot of renegotiations can be observed. In this case, firms will not take a renegotiation very seriously. This in turn will deteriorate the incentives of opportunistic banks to behave correctly, the reputation mechanism will break down. Only by rationing credit and selecting a small sample of firms with low risk, honest banks are still able to maintain a reputation. If honest banks are not able to decrease the credit risk in their sample below a critical value, no reputational equilibrium may be

sustainable and monitored finance may become impossible altogether. Contrary to the first scenario, this is a situation most probably encountered in highly unstable economies, for example in developing countries or economies in transition.

3.1 The model

There are two main methods of modelling reputation. One possibility is to construct an infinitely repeated game, where trigger strategies can be used to enforce a behavior which would be no equilibrium of the stage game. This approach has been used in most of the banking literature (e.g. Sharpe (1990), Bagnioli (1992), Dinc (1997)). However, for this kind of models it is important that the firms perfectly observe the banks action, as only one deviation or wrong observation leads to a breakdown of the reputational equilibrium. Since imperfect observability is crucial for explaining rationing, the approach is not very well suited for the purpose of this paper.

Therefore, in this paper, reputation is modeled in a finitely repeated game in the tradition of Kreps et alii. (1982), where the presence of irrationally honest types of players induces opportunistic players to mimic honest behavior. Benabou and Laroque (1992) or Fudenberg and Levine (1992) have shown that reputation is sustainable in these games even with imperfect observability of one player's actions. Since two repetitions of the stage game are already sufficient to observe credit rationing, the model is limited to this case. As usual in reputation games, more repetitions would decrease the fraction of honest and dishonest players necessary for sustaining the equilibrium, but not change the qualitative effects.

Assumptions Each period, a continuum with mass one of the firms described in section 2 arrives. The firms differ in the ex ante probability with which they enter in the risky state. They are ordered by riskiness and indexed by a parameter $x \in [0,1]$. A higher index x implies a higher risk. The ex ante probability with which a firm x enters in the risky state, even the owner invests the first best effort e^*, is denoted by $p(e^*, x)$. The fraction

$\lambda(x)$ of firms that enter in a risky state, if all firms with $x \in [0, \hat{x}]$ are financed, can then be calculated as:

$$\lambda(\hat{x}) = \frac{1}{\hat{x}} \int_0^{\hat{x}} p(e^*, x)\, dx. \tag{24}$$

It is assumed that, whereas monitored finance is possible, the moral hazard problem is too serious for arm's length finance to be feasible. Hence the firms have no access to the bond market. The firms have to get financed by a monopolistic bank which may be of one of three possible types. With probability $\boldsymbol{\alpha}$, the bank is **trustworthy** and only renegotiates the interest rate if firms have really entered in a risky situation. With probability $\boldsymbol{\beta}$, the bank is an **opportunist** who renegotiates the interest rate whenever this can be done without loosing future customers and with probability $\boldsymbol{\gamma} = 1 - \alpha - \beta$, the bank is a **usurer** who always exploits a big fraction $\frac{1}{2} < \lambda_u < 1$ of its customers. All types of banks strategically choose the fraction $\hat{x}$ of firms they want to finance. Only the opportunistic banks also decide strategically about the amount y of firms they want to exploit.

It is assumed that an opportunistic bank exploits successful and risky firms with equal probability. Exploitation will yield more for firms which are going to succeed than for firms which are going to enter in a risky situation. However, on expectation an exploiting bank will extract the first best surplus Π_{FB}. If opportunistic banks have decided not to exploit a firm they do not skim of the entire surplus, even when the firm enters in a risky situation. They only adapt the interest rate to the new risk.

There are two generations of firms. The firms of the second generation observe the amount of $\hat{x}$ firms financed, but have imperfect information about the behavior of the bank in the first period. This is modeled by assuming that they randomly draw two firms out of the sample financed by the bank in the first period. They are able to see if the interest rates of these two firms have been renegotiated, but they do not know whether this was justified or not. Depending on their observation, they decide to go to the bank or not to finance the project. If the risk of being exploited is too high, eventually the expected return will be

smaller than the effort they have to invest and they will give up their project.

Setting $\Pi_{Al} = e_{AL} = 0$ in equation 17 gives the profit which a non-exploiting bank is able to make, depending on the exploitation probability ρ expected by the firms.

$$\pi = \Pi_{FB} - \frac{e_{FB}}{(1-\rho)} \tag{25}$$

The critical exploitation level for which honest banks will not be able to offer a credit contract any more is $\hat{\rho} = 1 - \frac{e_{FB}}{\Pi_{FB}}$. For ρ higher than $\hat{\rho}$, the probability of not being exploited is so small that investing the necessary effort is not worthwhile for the firm.

The banks' strategies: In principle the bank decides each period about x and y if it is an opportunistic type or only about x if it is the honest type or the usurer. However, some of the choices can be trivially determined. As there is no reason to maintain a reputation after the last period of the game, all types of banks will finance the entire sample of the firms in the last period. In addition, opportunistic banks will exploit all firms.

As the second period's firms are able to perfectly observe the amount x of firms financed in the first period, the usurers and the opportunistic types have to exactly mimic the decision which is optimal for the honest bank. We can therefore reduce the decision variables of the banks to the amount x of firms financed in by the honest bank in the first period and the fraction y of firms exploited by the opportunistic types in the first period.

The firms' strategies: The first period's firms only have the choice to go to the bank or not. The information set of the second period's firms has the three possible elements "no renegotiation ", "one renegotiation", "two renegotiations". Hence they can choose among the three strategies: "go to every bank", "go to a bank which has less than two renegotiations", "only go to a bank if you do not observe a renegotiation".

Summarizing this discussion, after having eliminated the trivial choices, the game has the following structure.

Structure of the game:

1. In the first period, a continuum of firms seek finance.

1.1. Each firms decides whether to apply for credit or not.

1.2. The bank decides about the fraction x of firms it is willing to finance.

1.3. An opportunistic bank decides about the fraction y of firms it wants to exploit.

1.4. The stage game takes place for every firm.

2. In the second period, a new continuum of firms arrives

2.1. Every firm observes credit renegotiations for two old firms.

2.2. Every firm decides whether to apply for credit or not.

2.3. The stage game takes place.

It might be useful to recall the stage game:

1. The firms invest in effort.
2. The state of nature materializes for each firm.
3. Banks renegotiate interest rates.
4. The firms' outcome materializes and credit is paid back.

Two things can destroy a reputation mechanism in this setting: low profit margins and a too risky sample. If the gains from exploiting firms are very big compared to the rents earned with trustworthy behavior, the banks will have no incentives to sustain a reputational equilibrium. This is a well known effect which has been derived for example by Dinc (1997).

The second reason why the reputation mechanism can not be sustainable is the presence of too much good, but risky firms. If a lot of firms enter into the risky state, even trustworthy banks will have to renegotiate the interest rate quite often. This may make it difficult for a firm to distinguish between a usurer and a trustworthy bank. As a consequence, the firms may not react very severely upon observing a renegotiation of the interest rate. They will be willing to go to a bank even if they know that it has previously renegotiated credits, because they know that with a high probability is was justified. But then, the opportunistic

banks will realize that they can exploit at least some firms without losing a large number of customers in the future. Finally, if firms anticipate that opportunistic players will exploit them, they will prefer not to apply for credit. In such a situation, credit rationing can help to establish a reputational equilibrium, if it sufficiently reduces the average risk in the sample. We summarize this discussion in a proposition:

Proposition 1 *In situations where no reputational equilibrium is sustainable when all firms are financed, credit rationing can make lending possible if it reduces the risk of the bank's credit portfolio sufficiently.*

Proof. See Appendix A.0.1 ■

If the risk cannot be lowered sufficiently, finance may become impossible altogether. In this case only non profit-maximizing banks will still be able to provide credit.

In the above case, the trustworthy banks had to ration credit because otherwise no financing would have been possible. However, it may even be optimal to ration credit in situations where an unrationed reputational equilibrium would be sustainable. If a reputational equilibrium is sustainable, in the first period trustworthy banks earn $\pi_1 = \pi(\lambda_u \gamma)$ and in the second period $\pi_2 = \pi(\gamma + \beta)$ for each firm they finance.

If they finance a fraction x in the first period, in the second period with probability $1-(1-\lambda_t(x))^2$ a firm observes a renegotiation of the interest rate and prefers not go to the bank. Therefore, the two period profit of the bank will be:

$$x\pi_1 + (1-\lambda_t(x))^2 \pi_2 \tag{26}$$

Depending on the form of $\lambda_t(x)$, the maximum of this function may lie in the interior of $(0,1]$. In this case, the firm will ration credit in the first period. The first order condition

$$\pi_1 - 2(1-\lambda_t(x))\lambda_t'(x)\pi_2 = 0 \tag{27}$$

is necessary, but not sufficient. The interior maximum may not be the global one. Financing

all firms in the first period may still be more profitable. The following proposition summarizes this result.

Proposition 2 *Credit rationing occurs if the function* $x\pi_1 + (1 - \lambda_t(x))^2 \pi_2$ *has an interior maximum on* $(0, 1]$.

It is not easy to give more intuitive criteria to determine whether credit rationing will occur. A very simple example may help to reduce the number of parameters and facilitate the understanding. Assume $\pi_1 = \pi_2$ and that the sample only consists of a fraction ξ of riskless firms and $1 - \xi$ firms with the probability $\hat{p}$ of entering in the risky state.

Corollary 3 *Credit will be rationed if* $\hat{p} > \frac{1}{1+\sqrt{\xi}}$.

Proof. See Appendix A.0.2 ■

Credit rationing is more probable, the higher the fraction of riskless firms and the higher the risk of the risky firms. Intuitively, the first order condition $\pi_1 - 2(1 - \lambda_t(x))\lambda_t'(x)\pi_2 = 0$ holds if $\lambda_t'(x)$ is big and $\lambda_t(x)$ small, i.e. if by financing more firm one adds considerable risk to a relatively safe sample. At the same time, x should not be too small because then it might be more profitable to finance all risky firms instead of a few safe ones, i.e. then the maximum may be on the border.

3.2 Discussion

In this paper, only some of the consequences of the reputation-based approach have been explored. Some additional conclusions and possible extensions will be discussed in this paragraph.

For example, the model could be easily extended to explain excess liquidation by banks. Banks which are concerned about their reputation may prefer to liquidate risky firms instead of raising the interest rates, even if liquidation is inefficient. Contrary to raising the interest rate, liquidating is not profitable when applied to a healthy firm. It is only rational if

the firm is really in a difficult situation. Therefore, liquidation cannot be misinterpreted as an attempt to exploit informational rents. Liquidation will facilitate the establishment of reputation, but not solve the rationing problem. Now, the risky firms may be rationed because they are unprofitable if they are liquidated in a difficult situation.

Another simple extension would be the introduction of arm's length finance. Similar to the Rajan (1992) paper, the model could then be used to analyze the choice of a firm between bank and market finance.

Instead of assuming that there are different types of banks, the decision of the bank to exploit customers could also be related to the financial situation of the bank. Banks which are in a liquidity crisis may have to exploit customers in order to meet their obligations, or may just be unwilling or unable to provide credit when necessary. For example, prudential regulation limits the extend to which credits can be given by a bank in financial difficulties. Banks which finance a lot of risky projects may be more likely to enter in a liquidity crisis if they are not perfectly diversified. Peek and Rosengreen (1997) or Houston, James and Marcus (1996) provide evidence that the constraints of prudential regulations can be binding and that consequently credit supply changes with a bank's financial situation. Therefore, firms may prefer more stable banks. Of course, they also prefer stable banks because it may be difficult and expensive to obtain monitored credit from another bank if the own housebank has gone bankrupt.

4 Conclusion

Using the simplest possible mathematical specifications this paper has tried to formalize how a close financing relationship, which gives a bank a lot of bargaining power may increase efficiency but creates at the same time a commitment problem for the bank, which can only be solved by a possibly inefficient reputation mechanism.

The model has implications for bank management as well as for policy making. The most

important lesson is definitely that bank finance is fundamentally different from market-based financing through bonds and equity. Management and valuation techniques derived from the capital markets should not be simply applied to bank lending. Short-term profit oriented strategies, which neglect reputational concerns may have severe consequences when applied to a bank. It is of course always possible to cash in the reputation and briefly increase the profit of a bank, but this will have irreversible consequences for its future profits.

In particular, reputation can not only be destroyed by non-cooperative behavior. Frequent restructurations of the lending techniques and frequent changes in the bank personnel may also make the firms feel that the past may not be a good indicator for the bank's future behavior. Of course, changing a bank's image may help to increase a bank's reputation if it is already bad.

The model also underlines the importance of the loan officers and the informal information they posses. They should not only be considered as a costly distribution system of the bank's product. In particular, they, rather than the bank as a whole, may be the ones in which a firm trusts. Even if their information collection tasks could be carried out more efficiently by computerized scoring and credit supervision techniques, loan managers may be necessary for establishing reputation. This also confirms Mitusch's (1995) result that the monetary incentives of loan officers should not incite them to extract short term profits from the firm.

It has already been mentioned that the model can be used to justify the existence of non-profit maximizing banks, specialized in lending to small, innovative and risky firms. Another policy recommendation that can be justified with the model is to implement better transparency and disclosure regulations. This will facilitate the establishment of reputation and increase the competition of banks in the intermediary stage of a lending relationship.

An interesting side effect of the model is that the reputation of banks in general affects the feasibility of trustworthy behavior. If the probability of usurious behavior becomes too high, trustworthy banks will not be able to offer profitable contracts. This could also help to explain why the economic recovery after banking crises may be difficult. Tirole (1996)

shows that once the reputation of a group has been destroyed, for example by a random shock, it may be impossible to rebuild reputation. Therefore, if in a crisis a large number of banks had to exploit their customers in order to avoid bankruptcy, it will be difficult to re-establish the reputation-based relationship-banking.

A Appendix

A.0.1 Proof of proposition 1

Proof. Proposition 1 is proven by giving a generic example of an economy in which credit rationing occurs.

Let $\alpha = \beta = \gamma = \frac{1}{3}$, $\lambda_t = 0.2$, $\lambda_u = 0.7$, $\hat{\rho} = 0.6$, $\pi < \frac{\Pi}{2}$. Suppose that the risk profile of the ecopnomy is such that, by rationing credit and only financing a fraction $\hat{x}$, the average risk in the sample can be reduced to $\lambda_t(\hat{x}) = 0.1$. It will be shown that none of the firms' strategies leads to an equilibrium if all firms are financed. The only possibility for honest as well as opportunistic banks to build up a good reputation and finance firms is to reduce the amount of riskiness among their clients by reducing x, i.e. by rationing the more risky firms.

Solving the game by backward induction, the firms' strategies in the last period have to be considered first. Two possible strategies are feasible for the firms in the second repetition of the game:

a) The firms only go to a bank with clean track record

b) The firms also go to a bank if they observe not more than one renegotiation.

c) The firms go to a bank in any case.

Case a) What is the optimal amount of exploitation $y \in [0, 1]$ of the opportunistic player, given that firms do not go to a bank that they know to have renegotiated a credit? If an opportunistic bank chooses to exploit a fraction y of all firms, a fraction $\lambda_t + (1 - \lambda_t)\, y$ of

the firms has its credit contract renegotiated. With a probability of $[1-(\lambda_t+(1-\lambda_t)\,y)]^2$ no renegotiation of interest rates is observed in a randomly drawn sample of two firms. As there are no incentives to maintain a reputation after the game is finished an opportunistic bank will always exploit in the last period. Hence the two-period profit of an opportunistic bank can be calculated as:

$$\Pi y+\pi\,(1-y)+[1-(\lambda_t+(1-\lambda_t)\,y)]^2\,\Pi.$$

This function is obviously convex. It can therefore have no interior maximum, the maxima will be on the borders $y=0$ or $y=1$. If the bank exploits all customers its profit is Π. If the bank does not exploit any customer i.e. for $y=0$, the profit is $\pi+(1-\lambda_t)^2\,\Pi$. As $\pi=\frac{\Pi}{2}$, this can only be bigger than Π if .

$$\frac{\Pi}{2}+(1-\lambda_t)^2\,\Pi>\Pi$$

$$\Rightarrow \lambda_t<\hat{\lambda}_1=1-\sqrt{\frac{1}{2}}<0.29.$$

For small λ_t the opportunistic players have no incentives to exploit any firms in the first period, they will perfectly mimic the honest types. For higher λ_t the opportunistic banks will immediately exploit all firms.

Given this behavior, is it optimal for firms to go to banks with a clean track record, but not to banks for which they have observed at least one negotiation of the interest rate? We first assume that all firms in the sample are financed i.e. that $\lambda_t=0.2$.

No rationing:

Observing two non-renegotiated credit contracts, they believe that they will be exploited with probability:

$$\begin{aligned} P\,(\text{ex}|\text{clean}) &= \frac{\beta\,(1-\lambda_t)^2+\gamma\lambda_u\,(1-\lambda_u)^2}{(\alpha+\beta)\,(1-\lambda_t)^2+\gamma\,(1-\lambda_u)^2} \\ &= 0.52<\hat{\rho}. \end{aligned}$$

Since this is smaller than $\hat{\rho}$ firms will always go to a bank with a clean track record.

The probability of being exploited by a bank with mixed records is:

$$\begin{aligned} P\left(\text{ex}|\text{mixed}\right) &= \frac{\beta\lambda_t\left(1-\lambda_t\right)+\gamma\lambda_u^2\left(1-\lambda_u\right)}{\left(\alpha+\beta\right)\lambda_t\left(1-\lambda_t\right)+\gamma\lambda_u\left(1-\lambda_u\right)} \\ &= 0.58 < \hat{\rho}. \end{aligned}$$

and the probability of beeeing exploited by a bank with bad record

$$\begin{aligned} P\left(\text{ex}|\text{bad}\right) &= \frac{\beta\lambda_t^2+\gamma\lambda_u^2}{\left(\alpha+\beta\right)\lambda_t^2+\gamma\lambda_u^2} \\ &= 0.67 > \hat{\rho}. \end{aligned}$$

The probability of being exploited by a bank with clean as well as with mixed track record is smaller than $\hat{\rho}$, whereas the probability of beeing exploited by a bank with bad recored is higher than $\hat{\rho}$. In this case the firms will go to banks with clean and mixed records, which is contraditory to assumption a).

Rationing:

Rationing reduces the risk in the sample and increases the risk of beeing exploited after having obsered a mixed track record. The critical risk level can be calculated as

$$\begin{aligned} P\left(\text{ex}|\text{mixed}\right) &= \frac{\beta\lambda_t\left(1-\lambda_t\right)+\gamma\lambda_u^2\left(1-\lambda_u\right)}{\left(\alpha+\beta\right)\lambda_t\left(1-\lambda_t\right)+\gamma\lambda_u\left(1-\lambda_u\right)} = 0.6 \\ \Rightarrow\ & \lambda_t = 0.12. \end{aligned}$$

If a trustful bank reduces the risk of its sample to $\lambda_t\left(\hat{x}\right) = 0.12$, opportunists and usurers will have to follow. For $\lambda_t\left(\hat{x}\right) = 0.12$, firms will have no incentives to go to banks which have renegotiated and opportunists will have no incentives to exploit in the first period. Therefore this is an equilibrium.

Case b) It is assumed that the firms go to a bank if they observe not more than one renegotiation.

If firms think that in equilibrium they are only exploited by usurers, the opportunist's profit function is:

$$\Pi y + \pi (1 - y) + \left[1 - (\lambda_t + (1 - \lambda_t) y)^2\right] \Pi. \tag{28}$$

The profit for full exploitation is the same as in the previous case. However now the profit for complete honesty is $\pi + \left(1 - \lambda_t^2\right) \Pi$. The profit function is now concave and has a maximum at

$$y = \frac{\Pi - \pi}{2\Pi (1 - \lambda_t)^2} - \frac{\lambda_t}{(1 - \lambda_t)} > 0.14. \tag{29}$$

Hence the opportunistic players will exploit a nonzero fraction of the firms. This is not consistent with the firms' believes. Is an interior equilibrium possible? The opportunistic players are now renegotiationg a fraction $\lambda_{opp} = \lambda_t + (1 - \lambda_t) y = 0.31$ of the firms. Hence the probability of beeing exploited by a bank with mixed track recoprd is:

$$\begin{aligned} P(\text{ex}|\text{mixed}) &= \frac{\beta \lambda_{opp} (1 - \lambda_{opp}) + \gamma \lambda_u^2 (1 - \lambda_u)}{\alpha \lambda_t (1 - \lambda_t) + \beta \lambda_{opp} (1 - \lambda_{opp}) + \gamma \lambda_u (1 - \lambda_u)} \\ &= 0.61 > \hat{\rho}. \end{aligned}$$

and no firm will go to such a bank.

Case c) The probability of beeing exploited by a bank with a track recored of two renegotiations is:

$$\begin{aligned} P(\text{ex}|\text{bad}) &= \frac{\beta \lambda_t^2 + \gamma \lambda_u^3}{(\alpha + \beta) \lambda_t^2 + \gamma \lambda_u^2} \\ &= 0.67 > \hat{\rho}. \end{aligned}$$

As this is higher than $\hat{\rho}$ no firm will go to such a bank. ■

A.0.2 Proof of proposition 2

Given the assumption the risk profile is:

$$\lambda(\hat{x}) = \frac{1}{\hat{x}} \int_0^{\hat{x}} p(e^*, x)\, dx = \begin{cases} 0 & \text{for } \hat{x} < \xi, \\ \frac{p_2^2}{\hat{x}} (\hat{x} - \xi) & \text{for } \hat{x} \geq \xi. \end{cases} \tag{30}$$

We have

$$\lambda'(\hat{x}) = \begin{cases} 0 & \text{for } \hat{x} < \xi, \\ \xi \frac{p_2}{\hat{x}^2} & \text{for } \hat{x} \geq \xi. \end{cases} \tag{31}$$

The firm's profit is then

$$\Pi_{1+2}(x) = \begin{cases} \pi(x+1) & \text{for } \hat{x} < \xi, \\ \pi \left[1 + \left(1 - \frac{p_2^2}{\hat{x}} (\hat{x} - \xi) \right)^2 \right] & \text{for } \hat{x} \geq \xi. \end{cases} \tag{32}$$

Obviously the function is convex on $(\xi, 1)$.Therefore the maximum has to be either at $x = \xi$ or at $x = 1$.

The interior maximum at $x = \xi$ corresponds to the credit rationing equilibrium. It is the overall maximum if:

$$\pi(\xi + 1) > \pi \left[1 + \left(1 - p_2^2 (1 - \xi) \right)^2 \right], \tag{33}$$

$$\Leftarrow p_2^2 > \frac{1}{1 + \sqrt{\xi}}. \tag{34}$$

■

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